CLAIMS

What is claimed is:

1. A method for interleaving a plurality of data frames for transmission via a plurality of modems in a modem pool, where each of said data frames includes a plurality of code words having a predefined level of error correction, the method comprising:

assigning said plurality of data frames to a corresponding plurality of modem time frames, wherein a plurality of code word symbols in each of said data frames is assigned to a plurality of time slots in said modems in said corresponding time frames such that said predefined level of error correction is sufficient to correct error or loss caused to any of said symbols given a predefined level of modem loss or malfunction; and

moving any of said code word symbols assigned to one of said time frames to another of said time frames such that said predefined level of error correction is sufficient to correct error or loss caused to any of said symbols given a predefined level of cross-modem error burst while preserving said predefined level of error correction sufficient to correct error or loss caused to any of said symbols given said predefined level of modem loss or malfunction.

2. A method according to claim 1 wherein said assigning step comprises assigning such that each of said modems is assigned symbols from a plurality of code words.

3. A method according to claim 1 wherein said assigning step comprises assigning such that said code word symbols are divided as evenly as possible among said modems.

4. A method according to claim 1 wherein said assigning step comprises assigning where said plurality of data frames number at least X/Y, wherein X is the maximum number of expected errors in a code word given either of said predefined level of modem loss and said predefined level of cross-modem error burst, and Y is the maximum number of symbols that may be corrected in any given code word given said predefined level of error correction.

5. A method according to claim 4 wherein X is the maximum number of expected errors in a code word if interleaving is not employed.

6. A method according to claim 1 wherein said moving step comprises moving any of said code word symbols assigned to a modem time slot in one of said time frames to the same modem time slot in another of said time frames.

7. A method according to claim 1 wherein said moving step comprises moving such that each of said time frames includes code word symbols from a plurality of said data frames.

8. A method according to claim 1 wherein said moving step comprises moving such that said code word symbols are divided as evenly as possible among said time frames.

9. A method according to claim 1 and further comprising:

deriving a modem assignment vector for each of said data frames corresponding to the assignment of said code word symbols to said modems in any of said time frames; and

transmitting via said plurality of modems in said modem pool the code word symbols corresponding to the modem assignment vector in each of said time frames.

10. A method for interleaving a plurality of data frames for transmission via a plurality of modems in a modem pool, where each of said data frames includes a plurality of code words having a predefined level of error correction, the method comprising:

assigning said plurality of data frames to a corresponding plurality of modem time frames, wherein a plurality of code word symbols in each of said data frames is assigned to a plurality of time slots in said modems in said corresponding time frames such that said predefined level of error correction is sufficient to correct error or loss caused to any of said symbols given a predefined level of modem loss or malfunction;

constructing a matrix having a plurality of rows and columns, each row comprising a different one of said data frames and each column corresponding to one of said modems via which said code word symbols in said column are assigned; and

changing the order of the code word symbols in any of the columns of said matrix such that said predefined level of error correction is sufficient to correct error or loss caused to any of said symbols given a predefined level of cross-modem error burst while preserving said predefined level of error correction sufficient to correct error or loss caused to any of said symbols given said predefined level of modem loss or malfunction.

11. A method according to claim 10 wherein said assigning step comprises assigning such that each of said modems is assigned symbols from a plurality of code words.

12. A method according to claim 10 wherein said assigning step comprises assigning such that said code word symbols are divided as evenly as possible among said modems.

13. A method according to claim 10 wherein said assigning step comprises assigning where said plurality of data frames number at least X/Y, wherein X is the maximum number of expected errors in a code word given either of said predefined level of modem loss and said predefined level of cross-modem error burst, and Y is the maximum number of symbols that may be corrected in any given code word given said predefined level of error correction.

14. A method according to claim 13 wherein X is the maximum number of expected errors in a code word if interleaving is not employed.

15. A method according to claim 10 wherein said changing step comprises rotating each column in said matrix downward by C_N modulo F rows, wherein C_N is the column number of said column, F is the number of rows in said matrix, and column elements that are rotated past the bottom of said matrix are rotated to the top of said column.

16. A method according to claim 15 wherein said changing step comprises inversely ordering said columns prior to said rotating.

17. A method according to claim 10 wherein said changing step comprises rotating each column element in said matrix downward by $(A+B*C_N)$ modulo F rows, wherein F is

the number of rows in said matrix, A is a predetermined integer, B is a predetermined integer which is coprime to F, C_N is the column number of said column, and column elements that are rotated past the bottom of said matrix are rotated to the top of said column.

18. A method according to claim 17 wherein said changing step comprises rotating such that a column element in said column C_N and row R is moved to row $(R+A+B*C_N)$ modulo F.

19. A method according to claim 10 and further comprising:

deriving a modem assignment vector for each of said data frames corresponding to the assignment of said code word symbols to said modems in any of said rows; and

transmitting via said plurality of modems in said modem pool the code word symbols corresponding to the modem assignment vector in each of said rows.

20. A system for interleaving a plurality of data frames for transmission via a plurality of modems in a modem pool, where each of said data frames includes a plurality of code words having a predefined level of error correction, the system comprising:

a coder operative to encode a data stream into said plurality of code words; and

an interleaver operative to:

assign said plurality of data frames to a corresponding plurality of modem time frames, wherein a plurality of code word symbols in each of said data frames is assigned to a plurality of time slots in said modems in said corresponding time frames such that said predefined level of error correction is sufficient to correct error or loss caused to any of said symbols given a predefined level of modem loss or malfunction; and

move any of said code word symbols assigned to one of said time frames to another of said time frames such that said predefined level of error correction is sufficient to correct error or loss caused to any of said symbols given a predefined level of cross-modem error burst while preserving said predefined level of error correction sufficient to correct error or loss caused to any of said symbols given said predefined level of modem loss or malfunction.

21. A system according to claim 20 wherein said interleaver is operative to assign such that each of said modems is assigned symbols from a plurality of code words.

22. A system according to claim 20 wherein said interleaver is operative to assign such that said code word symbols are divided as evenly as possible among said modems.

23. A system according to claim 20 wherein said interleaver is operative to assign where said plurality of data frames number at least X/Y, wherein X is the maximum number of expected errors in a code word given either of said predefined level of modem loss and said predefined level of cross-modem error burst, and Y is the maximum number of symbols that may be corrected in any given code word given said predefined level of error correction.

24. A system according to claim 23 wherein X is the maximum number of expected errors in a code word if interleaving is not employed.

25. A system according to claim 20 wherein said interleaver is operative to move any of said code word symbols assigned to a modem time slot in one of said time frames to the same modem time slot in another of said time frames.

26. A system according to claim 20 wherein said interleaver is operative to move such that each of said time frames includes code word symbols from a plurality of said data frames.

27. A system according to claim 20 wherein said interleaver is operative to move such that said code word symbols are divided as evenly as possible among said time frames.

28. A system according to claim 20 and further comprising a demultiplexor operative to:

derive a modem assignment vector for each of said data frames corresponding to the assignment of said code word symbols to said modems in any of said time frames; and

transmit via said plurality of modems in said modem pool the code word symbols corresponding to the modem assignment vector in each of said time frames.

29. A system for interleaving a plurality of data frames for transmission via a plurality of modems in a modem pool, where each of said data frames includes a plurality of code words having a predefined level of error correction, the system comprising:

a coder operative to encode a data stream into said plurality of code words; and

an interleaver operative to:

assign said plurality of data frames to a corresponding plurality of modem time frames, wherein a plurality of code word symbols in each of said data frames is assigned to a plurality of time slots in said modems in said corresponding time frames such that said predefined level of error correction is sufficient to correct error or loss caused to any of said symbols given a predefined level of modem loss or malfunction;

construct a matrix having a plurality of rows and columns, each row comprising a different one of said data frames and each column corresponding to one of said modems via which said code word symbols in said column are assigned; and

change the order of the code word symbols in any of the columns of said matrix such that said predefined level of error correction is sufficient to correct error or loss caused to any of said symbols given a predefined level of cross-modem error burst while preserving said predefined level of error correction sufficient to correct error or loss caused to any of said symbols given said predefined level of modem loss or malfunction.

30. A system according to claim 29 wherein said interleaver is operative to assign such that each of said modems is assigned symbols from a plurality of code words.

31. A system according to claim 29 wherein said interleaver is operative to assign such that said code word symbols are divided as evenly as possible among said modems.

32. A system according to claim 29 wherein said interleaver is operative to assign where said plurality of data frames number at least X/Y, wherein X is the maximum number of expected errors in a code word given either of said predefined level of modem loss and said predefined level of cross-modem error burst, and Y is the maximum number of symbols that may be corrected in any given code word given said predefined level of error correction.

33. A system according to claim 32 wherein X is the maximum number of expected errors in a code word if interleaving is not employed.

34. A system according to claim 29 wherein said interleaver is operative to rotate each column in said matrix downward by C_N modulo F rows, wherein C_N is the column number of said column, F is the number of rows in said matrix, and column elements that are rotated past the bottom of said matrix are rotated to the top of said column.

35. A system according to claim 34 wherein said interleaver is operative to inversely order said columns prior to said rotating.

36. A system according to claim 29 wherein said interleaver is operative to rotate each column element in said matrix downward by $(A+B*C_N)$ modulo F rows, wherein F is the number of rows in said matrix, A is a predetermined integer, B is a predetermined integer which is coprime to F, C_N is the column number of said column, and column elements that are rotated past the bottom of said matrix are rotated to the top of said column.

37. A system according to claim 36 wherein said interleaver is operative to rotate such that a column element in said column C_N and row R is moved to row $(R+A+B*C_N)$ modulo F.

38. A system according to claim 29 and further comprising a demultiplexor operative to:

derive a modem assignment vector for each of said data frames corresponding to the assignment of said code word symbols to said modems in any of said rows; and

transmit via said plurality of modems in said modem pool the code word symbols corresponding to the modem assignment vector in each of said rows.

39. In a system comprising a plurality of data frames for transmission via a plurality of modems in a modem pool, where each of said data frames includes a plurality

of code words having a predefined level of error correction, interleaving apparatus comprising:

means for assigning said plurality of data frames to a corresponding plurality of modem time frames, wherein a plurality of code word symbols in each of said data frames is assigned to a plurality of time slots in said modems in said corresponding time frames such that said predefined level of error correction is sufficient to correct error or loss caused to any of said symbols given a predefined level of modem loss or malfunction; and

means for moving any of said code word symbols assigned to one of said time frames to another of said time frames such that said predefined level of error correction is sufficient to correct error or loss caused to any of said symbols given a predefined level of cross-modem error burst while preserving said predefined level of error correction sufficient to correct error or loss caused to any of said symbols given said predefined level of modem loss or malfunction.

40. Apparatus according to claim 39 wherein said means for assigning is operative to assign such that each of said modems is assigned symbols from a plurality of code words.

41. Apparatus according to claim 39 wherein said means for assigning is operative to assign such that said code word symbols are divided as evenly as possible among said modems.

42. Apparatus according to claim 39 wherein said means for assigning is operative to assign where said plurality of data frames number at least X/Y, wherein X is the maximum number of expected errors in a code word given either of said predefined level of modem loss and said predefined level of cross-modem error burst, and Y is the maximum number of symbols that may be corrected in any given code word given said predefined level of error correction.

43. Apparatus according to claim 42 wherein X is the maximum number of expected errors in a code word if interleaving is not employed.

44. Apparatus according to claim 39 wherein said means for moving is operative to move any of said code word symbols assigned to a modem time slot in one of said time frames to the same modem time slot in another of said time frames.

45. Apparatus according to claim 39 wherein said means for moving is operative to move such that each of said time frames includes code word symbols from a plurality of said data frames.

46. Apparatus according to claim 39 wherein said means for moving is operative to move such that said code word symbols are divided as evenly as possible among said time frames.

47. Apparatus according to claim 39 and further comprising:

means for deriving a modem assignment vector for each of said data frames corresponding to the assignment of said code word symbols to said modems in any of said time frames; and

means for transmitting via said plurality of modems in said modem pool the code word symbols corresponding to the modem assignment vector in each of said time frames.

48. In a system comprising a plurality of data frames for transmission via a plurality of modems in a modem pool, where each of said data frames includes a plurality of code words having a predefined level of error correction, interleaving apparatus comprising:

means for assigning said plurality of data frames to a corresponding plurality of modem time frames, wherein a plurality of code word symbols in each of said data frames is assigned to a plurality of time slots in said modems in said corresponding time frames such that said predefined level of error correction is sufficient to correct error or loss caused to any of said symbols given a predefined level of modem loss or malfunction;

means for constructing a matrix having a plurality of rows and columns, each row comprising a different one of said data frames and each column corresponding to one of said modems via which said code word symbols in said column are assigned; and

means for changing the order of the code word symbols in any of the columns of said matrix such that said predefined level of error correction is sufficient to correct

error or loss caused to any of said symbols given a predefined level of cross-modem error burst while preserving said predefined level of error correction sufficient to correct error or loss caused to any of said symbols given said predefined level of modem loss or malfunction.

49. Apparatus according to claim 48 wherein said means for assigning is operative to assign such that each of said modems is assigned symbols from a plurality of code words.

50. Apparatus according to claim 48 wherein said means for assigning is operative to assign such that said code word symbols are divided as evenly as possible among said modems.

51. Apparatus according to claim 48 wherein said means for assigning is operative to assign where said plurality of data frames number at least X/Y, wherein X is the maximum number of expected errors in a code word given either of said predefined level of modem loss and said predefined level of cross-modem error burst, and Y is the maximum number of symbols that may be corrected in any given code word given said predefined level of error correction.

52. Apparatus according to claim 51 wherein X is the maximum number of expected errors in a code word if interleaving is not employed.

53. Apparatus according to claim 48 wherein said means for changing is operative to rotate each column in said matrix downward by C_N modulo F rows, wherein C_N is the column number of said column, F is the number of rows in said matrix, and column elements that are rotated past the bottom of said matrix are rotated to the top of said column.

54. Apparatus according to claim 53 wherein said means for changing is operative to inversely order said columns prior to said rotating.

55. Apparatus according to claim 48 wherein said means for changing is operative to rotate each column element in said matrix downward by $(A+B*C_N)$ modulo F rows,

wherein F is the number of rows in said matrix, A is a predetermined integer, B is a predetermined integer which is coprime to F, C_N is the column number of said column, and column elements that are rotated past the bottom of said matrix are rotated to the top of said column.

56. Apparatus according to claim 55 wherein said means for changing is operative to rotate such that a column element in said column C_N and row R is moved to row $(R+A+B*C_N)$ modulo F.

57. Apparatus according to claim 48 and further comprising:

means for deriving a modem assignment vector for each of said data frames corresponding to the assignment of said code word symbols to said modems in any of said rows; and

means for transmitting via said plurality of modems in said modem pool the code word symbols corresponding to the modem assignment vector in each of said rows.